The Features of KA-BAND in the North-Western region of RUSSIA

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***Abstract*: The main objective of the project - to provide new data about the signal strength and coverage of the actual signal Ka-band beams 75 and 76 satellite Ka-Sat in the Arkhangelsk region, Murmansk Oblast and Nenets Autonomous District, the Barents and the White Sea and the development of experimental design of the sample measurement equipment Ka-band for the Far North. Applications coverage maps - Arkhangelsk and Murmansk Oblast and Nenets, Barents and White seas. The cards will be used for the organization of high-quality satellite broadband communications and Internet services for coastal developments and the shelf of the Arctic Ocean. Experimental Design sample measurement equipment Ka-band will serve as a prototype for similar devices.**

Keywords: Ka-Band, Ka-Sat, VSAT

I. Introduction

Currently, the Russian Federation, the priority is development of telecommunications. To the north of Russia and the Arctic is the most appropriate use of space communications. Ka-band - a promising range of frequencies and millimeter waves, allowing end users to provide multimedia services and broadband Internet access. In now time, spacecraft communications with home-made Ka-band transponders are in production. In the northern latitudes of Russia, there are two beams of a foreign satellite Ka-Sat, partially covering the territory of Arkhangelsk and Murmansk regions and the NAO and the Barents and White Seas. The signal strength in these areas and cover only known in theory. In practice, not referring to the prevalence of ground equipment on the territory of the Russian Federation, have not been studied possibilities of technology-based communication Ka-band. The aim of this work is to reveal the possibilities and limitations of using this range in the far north of Russia.

In the first phase of the study examined the signal propagation characteristics in Ka-band. Special attention is given to the choice of ground equipment. The analysis showed that the most suitable for the research is samopozitsioniruyuschiesya antenna systems iNetVu (Fig. 1), which are able to find any satellites operating in Earth orbit of the Earth, and quickly positioned to provide access to services and to the Internet in minutes. INetVu systems provide high-speed access to the Internet and are focused on a wide range of tasks and users. iNetVu systems are easily mounted on the roof of any vehicle. The first tests of the system on the ship, "Professor Molchanov" showed the possibility of organizing a stable connection, but also revealed some shortcomings in the guidance system of the satellite. Currently under correction software (Figure 1).

Fig.1. . iNetVu® 750 Auto Deploy Antenna (75cm VSAT)

II. VSAT technology

At present a review of produced micromechanical sensors for the planned navigation system [3] was selected sensor LSM330DL production STMicroelectronics, which contains a three-axis accelerometer, three-axis gyro sensor. The sensor has several ranges of linear accelerations and angular velocities. The data is exchanged in digital form, the three protocols are supported.

To start I would like to consider the characteristics of application of technology VSAT. Any network query consists of two main operations - a request to the subscriber interest and response from him. The channel through which the response is usually referred to as Direct

channel and the channel on which requests should be passed is called a Back channel. In conventional satellite communication networks as a Back channel uses different ground lines of communication, such as the telephone network, mobile communications. As a Direct channel is used satellite channel. This scheme is illustrated in Figure 2.

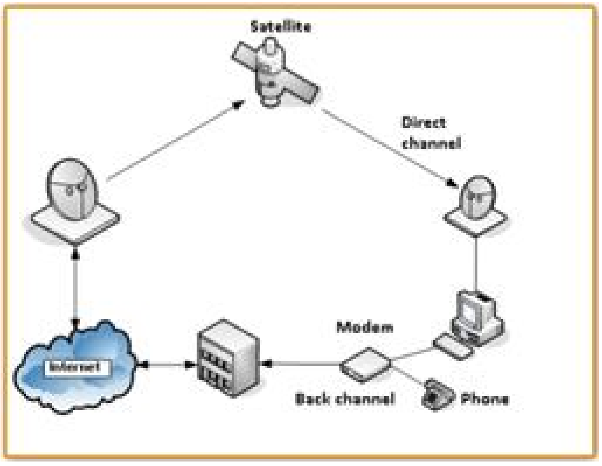

Fig.2. The scheme of the classical satellite internet

Obvious serious drawback of this scheme - in the absence of the possibility of using land lines for the organization of the return channel, the organization of two-way communication becomes impossible.

The technology allows the use of VSAT satellite channel in both directions. To do this, antenna transceiver set up to 6 Watts. All connection fees processed by the central HUB. Thus, network access may be provided at any point where there is coverage satellite, without use of additional communication lines (Figure 3).

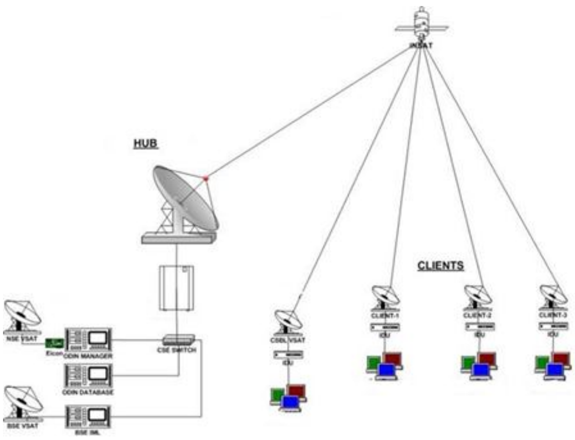

Fig.3. The scheme of the VSAT

At the moment, for VSAT technology are two main frequency bands - Ku and Ka. Ku band is the range of centimeter wavelengths, Ka is the centimeter and millimeter. The most promising is the use of band Ka, since in this case the following advantages:

- possible to reduce the size of the antenna satellite terminal to 0.74, or even 0.5 m;
- internet speed is comparable to the various terrestrial and wireless technologies and is up to 4 Mbps transmission and up to 20 Mbps at the reception;
- low-cost terminal;
- easy installation and the ability to automatically adjust the satellite station.

Unfortunately, Russia does not yet have their own communication satellites with support for a range of Ka, so in our work we used the satellite KA-SAT, owned by "Eutelsat". It is located at 9 ° on the geostationary orbit. Two-way satellite transmission equipment is able to generate 82 spot beam. Coverage is shown in Figure 4.

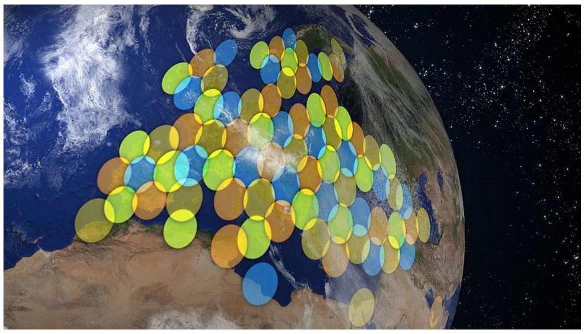

Fig.4. Coverage area of the satellite Ka-SAT.

Two beams covering northern European part of the Russian Federation (Figure 5). They were the object of our study. In Russia the introduction of technology Ka-VSAT engaged in Federal State Unitary Enterprise "Satellite Communications Company". They were leased transponders on the part of the KA-SAT.

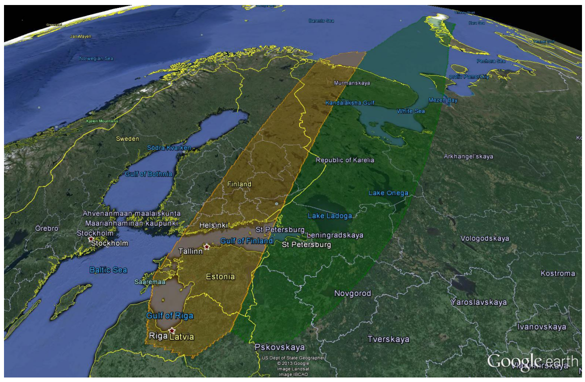

Fig.5. 75 and 76 beams.

III. EXPERIMENTAL STUDY

The study was conducted in the form of a car expedition route through 75 (green) and 76 (orange) beams. The expedition was supported by the Federal State Unitary Enterprise "Russian Satellite Communications Company". For the study, we used the following equipment (Figure 6,7):

- Terminal C-Comsat iNet Vu Ka-75 V Ka Platform
- Controller CTR - 7024 - 10C
- Satellite modem Tooway Surfbeam2
- Transceiver 3 W

- Spectrum Analyzer NI PXI 5660 as part of the chassis based on NI PXI 1042Q controller with NI PXI 8108
- Own software to automatically collect telemetry data from the modem and controller
- Weather station Oregon Scientific WMR 88

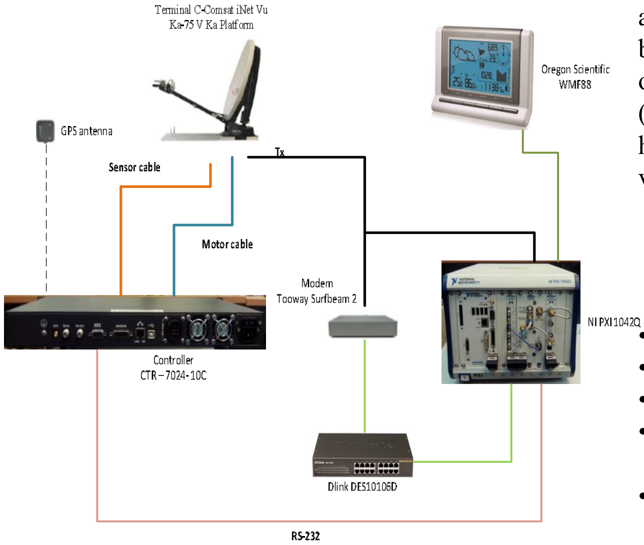

Fig.6. Circuit connection of the equipment.

Fig.7. Placement of equipment on the car

Measurements were carried out approximately every 50 km. At the point of measurement was performed antenna pointing, telemetry collection for half an hour and sending to a central server. Telemetry was the testimony of a modem controller, a spectrum analyzer, the weather station. Co-starring the results of the speed test internet connection. Channel data was kindly provided by Federal State Unitary Enterprise "Satellite Communications Company".

IV. Findings

Let us consider separately the results for each beam. 75 beam captures the north-western part of the Arkhangelsk region, Onega region and the south-east part of the Republic of Karelia. The green beam is characterized by high Rx SNR, especially in the Onega region (Figure 8). This is not surprising, since the northern areas have a relatively low elevation angle of the antenna (12-14 degrees), while we studied area is not characterized by the presence of high obstacles in the direction of antenna pointing. Horizon in these places clean and well looked, and nothing prevents the signal.

76 (orange) beam (Figure 9) was more rich in interesting facts. It was found that with a beam width of about 200 km, it is almost halfway to the east is blocked 75 beam (Figure 10). Moreover, the signal green beam in the orange is not inferior to the level of the signal orange beam (Figure 11). A 76 beam covers the territory of the Republic has Karelia and the Murmansk region in which there are a variety of different heights, which interfere with the signal.

V. The main problem of application of Ka-VSAT in the northern latitudes

Unfortunately, there were some drawbacks:

- Low elevation
- Hilly and highland
- The dependence of the signal on the weather conditions
- The need to be selected carefully place the antenna, or to increase the height of the antenna
- It is desirable to use high-power transmitters (more than 3 Watts)

In northern elevation is low enough (12-14 degrees), so the presence of even small elevations in the direction of pointing the antenna reduces the signal strength. This is especially critical for the Back channel as the transmit power is small and as a result, the signal can not pass through the obstacle. Therefore, for high-quality guidance has to carefully choose the place of installation. Also plays a big height of the antenna. In our case, it was only 2.4 meters. At this altitude, most of the obstacles (hills, hills, mountains) prevent direct view of the satellite. Increasing the height of installation allows you to bypass this limitation.

VI. Conclusion

We believe that, despite some shortcomings, Ka-VSAT technology can and should be applied in the extreme north. Low-cost channels and equipment allows for wide distribution. Simplicity and ease of installation can reduce the cost of deployment of the client terminal. The small size of the reflector can not be afraid of strong gales and high enough levels of signal reception will provide a good channel of communication.

References

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Attachments

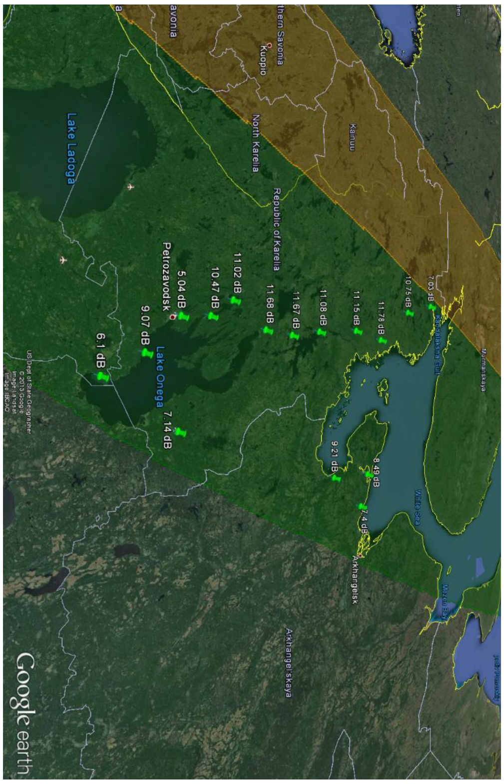

Fig.8. Rx SNR on 75 beam

Fig.9. Rx SNR on 76 beam

Fig.10. Penetration 75 76 Beam

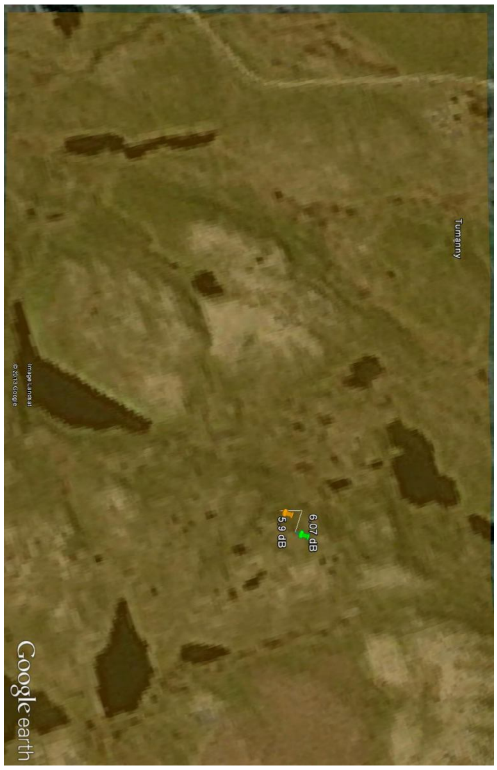

Fig.11. Indications on the border beams